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(54) **A capacitor and method of manufacture thereof**

(57) The purpose of this invention is to provide a ferroelectric capacitor and a ferroelectric memory device, which can perform stable operation without causing a resistivity change that is considered to be caused due to the leakage current and the oxygen diffusion; in which it is difficult for dielectric fatigue to be caused in the ferroelectric capacitor, even by repeated inversions; and in which long life and high reliability can be maintained; and to provide their manufacturing method. The constitution of this invention includes a ferroelectric capacitor CAP which has Ir lower electrode (13), PZT thin film (14), and Ir upper electrode (15) and in which crystal grain layers (14a, 14b, and 14c) constituted by assembling crystal grains (50a, 50b, and 50c) by means of grain boundaries (51a, 51b, and 51c) are laminated by means of grain boundaries (52A and 52B) along the surface of the Ir electrode (13), so that the ferroelectric film (14) is formed. A method for manufacturing the ferroelectric capacitor CAP, which meets all of the important conditions of 1) selection of an optimum electrode substance such as Ir; 2) control of crystal growth direction by means of TiO<sub>2</sub> nucleus attachment and a surplus of Pb; and 3) optimum annealing temperature for eliminating surface precipitates; and which deposits a titanium oxide, forms a ferroelectric film material layer containing a surplus of lead on it, heats it at a temperature at which the surface precipitates are substantially lost, and laminates each

crystal grain layer (14a, 14b, and 14c) by repeating the above processes.

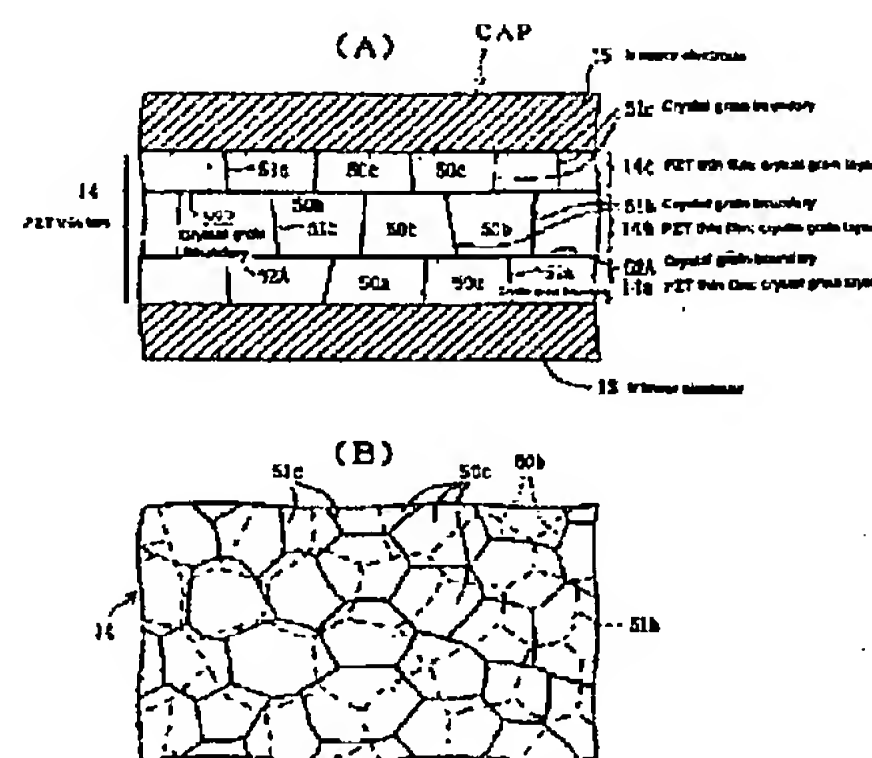


FIG. 1. Structure of the PZT thin film capacitor of this embodiment

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## EUROPEAN SEARCH REPORT

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| DOCUMENTS CONSIDERED TO BE RELEVANT  |  |   |   |
|--|--|---|---|
| Category   | Citation of document with indication, where appropriate, of relevant passages  | Relevant to claim                                   | CLASSIFICATION OF THE APPLICATION (INCL.6)    |
| X<br>A   | US 5 434 742 A (SAITO KATSUAKI ET AL)<br>* column 21; figure 49; example 8 *<br>* column 39; example 35 *  | 1,2,4,5<br>3,6,8                                    | H01L27/115<br>H01L21/3205                     |
| X  | EP 0 705 918 A (TEXAS INSTRUMENTS INC)<br>* figure 2 *   | 1,2,4,5   |   |
| X  | EP 0 571 949 A (TEXAS INSTRUMENTS INC)<br>* claims 1-13 *  | 1,2,4,5   |   |
| X  | PATENT ABSTRACTS OF JAPAN<br>vol. 018, no. 388 (E-1581), 20 July 1994<br>& JP 06 112543 A (SEIKO EPSON CORP), 22 April 1994,<br>* abstract *   | 1,2,4,5   |   |
| A  | NAKAMURA T ET AL: "PREPARATION OF<br>PB(ZR,TI)O3 THIN FILMS ON ELECTRODES<br>INCLUDING IRO2"<br>APPLIED PHYSICS LETTERS,<br>vol. 65, no. 12, 19 September 1994,<br>pages 1522-1524, XP000470279<br>* page 1522 * | 3   | TECHNICAL FIELDS<br>SEARCHED (INCL.6)<br>H01L |
| A  | CUPPENS R ET AL: "FERROELECTRICS FOR<br>NON-VOLATILE MEMORIES"<br>MICROELECTRONIC ENGINEERING,<br>vol. 19, 1992,<br>pages 245-252, XP002026229<br>* page 247, paragraph 2 *                                      | 7   |   |
| -/--   |  |   |   |
| The present search report has been drawn up for all claims   |  |   |   |
| Place of search<br>BERLIN  |  | Date of completion of the search<br>4 November 1997 | Examiner<br>Juhl, A                           |
| CATEGORY OF CITED DOCUMENTS<br>X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document<br>T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>A : member of the same patent family, corresponding document |  |   |   |

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|---|---|---|--|
| Category  | Citation of document with indication, where appropriate, of relevant passages   | Relevant to claim                                   | CLASSIFICATION OF THE APPLICATION (Int.Cl.6) |
| A   | MOAZZAMI R ET AL: "INTEGRATION OF FERROELECTRIC CAPACITOR TECHNOLOGY WITH CMOS"<br>SYMPOSIUM ON VLSI TECHNOLOGY. DIGEST OF TECHNICAL PAPERS, HONOLULU, JUNE 7 - 9, 1994,<br>no. SYMP. 14, 7 June 1994, INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS,<br>page 55/56 XP000498580<br>* page 55, paragraph 2 * | 9,13-15   | TECHNICAL FIELDS<br>SEARCHED (Int.Cl.6)      |
| A   | PATENT ABSTRACTS OF JAPAN<br>vol. 018, no. 604 (C-1275), 17 November 1994<br>& JP 06 228736 A (TDK CORP), 16 August 1994,<br>* abstract *   | 10  |  |
| A   | PATENT ABSTRACTS OF JAPAN<br>vol. 018, no. 171 (E-1529), 23 March 1994<br>& JP 05 343642 A (SEIKO EPSON CORP), 24 December 1993,<br>* abstract *  | 10-12   |  |
| A   | JIA Q X ET AL: "LOW LEAKAGE CURRENT BATIO3 THIN FILM CAPACITORS USING A MULTILAYER CONSTRUCTION"<br>THIN SOLID FILMS,<br>vol. 259, no. 2, 15 April 1995,<br>pages 264-269, XP000512226<br>* figure 8 *  | 1,5   |  |
| The present search report has been drawn up for all claims  |   |   |  |
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